

Because the Examiner has not specifically identified the specific subject matter that he asserts is not described in the specification, the Applicants will attempt to address the rejection in general without the benefit of specificity. This is especially problematic to the Applicants in this instance, because the Examiner has applied the rejection to all of the pending claims that cover a significant breadth of features and subject matter. If the Examiner requires more specific information regarding a specific feature or features in the claims, the Examiner is earnestly requested to contact the undersigned to discuss the matter in greater detail or in the alternative, to issue a subsequent Office Action explaining the Examiner's position more clearly.

The Applicants will focus the discussion on the independent claims. One instance of specification support for independent claim 1 is found on pages 17 through 19 of the specification, in conjunction with the information found in Figures 1 and 2. For example, Figure 2 illustrates a linear array that includes 80 transducer elements, which are arranged in a straight line at intervals equal to half the wavelength of incoming signals. On page 20 (middle portion of the last paragraph on the page), the specification states that Figure 2 is illustrative of an embodiment where the scanning cycle corresponds to four times the wavelength (in other words at a specific scanning frequency). Figure 1 illustrates an oblique-line sampling scheme where the sampling operation is performed sequentially from element 0 to element 159 (bottom of page 19). Figure 1 shows the arc-shaped form of the arrangement of the plurality of ultrasonic transducer elements into multiple blocks and as described in the first full paragraph on page 20.

The same instances of support apply for the features recited in independent claim 9. Figure 6 (described in detail as an exemplary embodiment beginning on page 25 of the specification) and Figure 13 (described in detail as an exemplary embodiment beginning on page 46) provide the specification support for independent claim 10 and enumerate the various circuit elements and components that make up exemplary embodiments of the present invention.

The Applicants hope that they have addressed the Examiner's rejection regarding the independent claims and respectfully submit that the rejection be withdrawn. The Applicants have analyzed the independent claims to be responsive to the Examiner's Office Action and to provide the Examiner with examples of the type of information that is required to overcome this type of rejection and the importance of specificity to the Applicants in formulating a response. However, again, as mentioned above, if the Examiner's specific concerns have not been addressed, the Applicants believe that the rejection is improper and respectfully request that more detail regarding the 35 U.S.C. §112, first paragraph rejection be provided, so that they can be addressed.

Claims 19 and 20 are rejected under 35 U.S.C. §102(b) as being allegedly anticipated by Gilmour, U.S. Patent No. 4,262,344. Applicants respectfully traverse the rejection.

Claim 19 is directed towards a beam-forming method in which the echo signals received by multiple ultrasonic transducer elements arranged in a linear form are sampled at a specific scanning frequency to obtain sample data. The receiving beam-

forming apparatus comprises, *inter alia*, a memory that stores the sample data derived from multiple scanning cycles, a sampling plane generator that produces a continuous sample data train and a beamformer which forms a receiving beam in a specific direction using the sample data.

Claim 20 is directed towards a receiving beam-forming apparatus which repeatedly samples echo signals received by multiple ultrasonic transducer elements at a specific scanning frequency and forms a receiving beam using sample data obtained by sampling the echo signals in multiple scanning cycles.

This is in contrast to the Gilmour patent which discloses a side looking sonar beam forming apparatus that generates a plurality of sets of radially extending beams in a chirp Z-transform sonar beam former. More particularly, we would like to point out Figure 2 of the preferred embodiment of the present invention depicts six waves having a short duration which do not touch on all the transducer elements at the same one time. This is very different from Figures 5A through 5D in the Gilmour patent that uses waves having a long duration which touch on all of the transducer elements at one time. In Figures 5A through 5D of Gilmour, the transducer is assumed to be made up of an infinite number of infinitesimal elements. In Figure 5C, the wave direction associated with the beam produces a plurality of maximum and minimum voltages along the length of the transducer resulting in the waveform having twice the frequency of the waveform.

Figure 2 of the present application illustrates an application of the invention to the formation of a receiving beam using a linear array. This Figure 2 is a sampling time chart showing a case in which 15 scanning cycles ($N-7$ to $N+7$) of in-phase (I) and quadrature

(Q) data sampling operation and each scanning cycle corresponding to four times the wavelength, are repetitively conducted using 10 at a time from left to right of the linear array in a step like form.

Besides the differences noted above, another important feature the present invention possesses is the ability to address and solve problems that are caused by waves having a short duration. Conversely, in the Gilmour patent, the problems that are solved by the present invention are not found nor even suggested therein.

For at least these reasons, the Applicants respectfully request that the rejection be withdrawn and that claims 19 and 20 be allowed.

Claims 1-11 are rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over the PCT patent WO 96/03919 ('919) or Wright et al., U.S. Patent No. 5,667,373 when taken in view of Gilmour, U.S. Patent No. 4,262,344. Applicants respectfully traverse this rejection.

Wright et al. discloses a method for forming a coherent image. More particularly, an ultrasonic diagnostic apparatus is disclosed which is constructed to form a synthetic scan line between transmit scan lines. A transmit scanline is a line on which an associated transmit beam is presumed to lie. Synthetic scan lines are scan lines that are distinct from any receive scan lines and/or any transmit scan lines.

Again, this is in contrast to the operation of the preferred embodiment of the present invention where Figure 2 depicts six waves having a short duration which do not touch on all the transducer elements at the same one time.

Furthermore, WO96/03919 discloses a multi-beam base band processor for making post-beam formation adjustments to the complex (inphase/quadrature) pre-detection scan line samples acquired from a receive beam former of an ultrasound imaging system. This patent includes a programmable finite impulse response (FIR) filter and a programmable complex multiplier, where the filter performs signal shaping and sample rate conversion.

Again, this is in contrast to the operation of the present invention as delineated above. The Applicants do not agree with the Examiner's assertion that it would have been obvious to modify the Wright et al. reference to make up for the missing features of the reference. However, the Applicants respectfully submit that the present invention is clearly distinguishable over the applied art since it does not disclose the specific feature mentioned above and the additional limitations discussed in the secondary reference do not make up for the deficiencies of the primary reference.

Therefore, based upon the preceding information, the Applicants respectfully request that independent claim 1 be allowed and dependent claims 2-4 be allowed for at least the reasons set forth above regarding the independent claim.

Claim 5 of the present invention is directed to a beam-forming method comprising the steps of dividing a plurality of ultrasonic transducer elements arranged in a linear form into multiple blocks and repeatedly sampling signals received by the individual ultrasonic transducer elements at a specific scanning frequency. Sample data derived from different scanning cycles for the individual blocks is selected and a receiving beam is formed in a specific direction using the selected sample data.

This is in contrast to the methods disclosed in the PCT patent ('919) or the Wright et al. patent ('373) (which the Examiner submitted in the alternative). In the PCT patent ('919), each scan line of a transmit or receive scan pattern can be parameterized by the origin on the transducer array, the scan line orientation (angle Θ) and the focus depth or range (r). The ultrasound imaging system stores a pre-computed sparse data set and aperture values indexed by these parameters and based upon geometric considerations.

In the Wright et al. patent, a method is disclosed where coherent signals representative of a signal from an object are acquired and these coherent signals are used to generate synthetic samples on synthetic scan lines which are spatially distinct from the receive scan lines on which a signal was reflected from the object.

Wright et al.'s usage of synthetic scan lines between the transmit scan lines are very different from the operation of the present invention as claimed in claim 5. The rejection based on the Gilmour reference is defective for the same reasons provided above.

Therefore, for at least the foregoing reasons, the Applicants respectfully request that the rejection be withdrawn and that independent claim 5 be allowed, and that dependent claims 6-8 be allowed for at least the same reasons. Claims 9 and 10-11 also recite features in a manner that are distinguishable in a similar manner to the arguments provided above regarding the applied references.

Therefore, for at least the reasons presented above, the Applicants respectfully submit that the rejections be withdrawn and that claims 1-11 be allowed.

The Applicants believe that they have addressed all of the Examiner's rejections and that all of the pending claims are in condition for allowance.

CONCLUSION

All objections raised in the Office Action having been addressed, it is respectfully submitted that the present application is in condition for allowance and such allowance is respectfully solicited. Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John L. Ciccozzi, Reg. No. 48,984, at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Attached hereto is a marked-up version of the changes made to the application by this Response.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART KOLASCH & BIRCH, LLP

By

Michael K. Mutter, #29,680

MKM/JLC/kmr
0757-0225P

P.O. Box 747
Falls Church, VA 22040-0747
(703) 205-8000